

sinuate, its posterior angles dilated; mesonotum (including the cruciform elevation) almost as long as head and pronotum together; abdomen longer than space between apex of head and base of cruciform elevation; tympana completely exposed, coverings entirely absent; face more or less centrally sulcate; rostrum reaching the intermediate coxæ; opercula small, transverse; abdomen beneath with the lateral margins broadly recurved; tegmina and wings semiopaque; tegmina with the basal cell about twice as long as broad; apical areas short in length, eight in number, a curved rudimentary vein, curved inwardly, crossing tegmen from base of first ulnar area to base of lower apical area; posterior tibiæ with a few fine spines.

Type, *T. cupreosparsa*, Uhler (*Tibicen*).

XXV.—*Some Cretaceous and Tertiary Cirripedes referred to Pollicipes.* By THOMAS H. WITHERS, F.G.S.

[Plates VII. & VIII.]

THE Cirripedes discussed in this paper include certain sessile forms belonging to the family Brachylepadidæ and a number of pedunculate forms of the family Pollicipedidæ. For the sake of convenience, they are dealt with in the following order:—(1) the species herein referred to the genus *Brachylepas*; (2) a group of species now included in a new genus *Pycnolepas*; and (3) certain species that can now be proved to belong to the more primitive forms of *Scalpellum* (*sensu lato*) included in the subgenus *Scillælepas* of the genus *Calantica*. All these have been hitherto referred to *Pollicipes*.

Darwin, in his Monograph on the fossil pedunculate Cirripedes, distinguished the whole of the described species as either *Pollicipes* or *Scalpellum*, and determined certain characters by which one could distinguish the separate valves of the species belonging to those two genera. Except for the more advanced forms of *Scalpellum* (*sensu lato*), these distinctions can no longer be followed, and as our knowledge of the fossil pedunculate forms increases, it becomes more evident that the reference of many of these to the genus *Pollicipes* can not be maintained; indeed, it will probably be found eventually that very few really belong to that genus.

All the fossil species in which the valves are not modified to the extent obtaining in those of *Scalpellum* were included by Darwin in *Pollicipes*; but it is evident now that some of these are really primitive forms of *Scalpellum* (*sensu lato*), and that others belong to forms quite distinct from *Pollicipes*.

If we consider that *Pollicipes* or a *Pollicipes*-like Cirripede was the ancestral type which gave rise to the various forms of pedunculate Cirripedes and to certain sessile forms, we are not at all surprised to find in the Cretaceous rocks a group of species, which, while in some instances retaining the *Pollicipes* type of valve, were modified in respect to the number, relative position, and structure of the valves of the capitulum. Such forms as the pedunculate Cirripedes *Zeugmatolepas**, *Calantica* (*Scillelepas* and *Titanolepas**), and *Pycnolepas*, gen. nov., and the sessile Cirripede *Brachylepas*, illustrate this point.

All of these possess valves which, if found separately, would unhesitatingly be referred to either *Pollicipes* or *Scalpellum* (*sensu lato*), and, indeed, such has always been the case. *Zeugmatolepas* and *Titanolepas*, however, possess valves which, if found singly, would have been referred some to *Pollicipes* and others to *Scalpellum*.

Hence, until we can piece together the whole or the greater part of the capitulum in certain of the less modified species, it is obvious that no true idea of their affinities can be attained. It is in this direction that future work must lie, and much work is necessary before the phylogeny of the group can be studied with advantage.

The purpose of this paper is to discuss certain of these forms from this standpoint, with a view to indicating their phylogenetic position.

Family Brachylepadidæ.

Sessile barnacles in which the shell is composed of an upper whorl of 8 valves, namely, a widely semiconical carina, paired scuta, paired long and narrow upper latera, and a rostrum almost equalling the carina in size, with four whorls of subtriangular imbricating plates encircling the bases of the valves of the upper whorl. Basis probably membranous.

The family consists of the single genus *Brachylepas*.

* Withers, T. H., Proc. Zool. Soc. London, 1913, pp. 938, 943.

GENUS BRACHYLEPAS, II. Woodward.

1901. *Brachylepas*, II. Woodward, Geol. Mag. dec. iv. vol. viii. p. 150.

Genotype. *Brachylepas naissantii*, Hébert, sp.

The genus *Brachylepas* and the family Brachylepadidæ were founded to embrace the single species *Pyrgoma cretacea* from the *B. mucronata*-zone of Norwich, and subsequently (1906, Geol. Mag. dec. v. vol. iii. pp. 339-340) Dr. Woodward referred to *Brachylepas* the species *Mitella lithotryoides*, Bosquet, from the Maestrichtian of Holland, and *Pollicipes fallax*, Darwin, from the Upper Senonian, *B. mucronata*-zone of Norwich. A recent paper (Withers, 1912, Geol. Mag. dec. v. vol. ix. p. 321) proved the identity of *Brachylepas cretacea* with the valve figured by Ed. Hébert (1855, Mém. Soc. géol. France, ser. 2, vol. v. p. 374, pl. xxix. fig. 10) as *Emarginula* (?) *naissantii*, whence the name of the genotype became *Brachylepas naissantii*, Hébert, sp. The type-species was fully discussed and a restoration given (reproduced, text-figure 5, p. 201).

Now that we know the form, number, and disposition of the valves comprising the capitulum of *B. naissantii*, we can discuss the species *Mitella lithotryoides* and *Pollicipes fallax*. The last-named species is dealt with under the new genus *Pycnolepas* (see p. 175).

Brachylepas lithotryoides, Bosquet, sp.

1857. *Mitella lithotryoides*, J. Bosquet, Notice sur quelques Cirripèdes récemment découverts dans le Terrain Crétacé du Duché de Limbourg, p. 23, pl. iii. figs. 5-10.

1857. *Mitella fallax*, Darwin, sp., *tom. cit.* p. 21, pl. ii. figs. 8-12, pl. iii. figs. 1, 2.

1906. *Brachylepas lithotryoides*, Bosquet, sp.; H. Woodward, "Cirripedes from the Trimmingham Chalk and other localities in Norfolk," Geol. Mag. dec. v. vol. iii. p. 339, figs. 1-4.

Of *Mitella lithotryoides* Bosquet figured carinæ, a scutum, upper latus, rostrum, and a subrostrum. The subrostrum and one of the carinæ have at the base at least two whorls of imbricating plates, of which some show exteriorly a median basal notch, just as in *B. naissantii*. The so-called subrostrum is evidently a rostrum, for it is wider in proportion to its length than the carina, and, like the carina, has a series of imbricating plates at its base; it therefore could not have served as a subrostrum. Although the presence of a median basal notch in some of the imbricating plates

shown in Bosquet's figures renders it very probable that the plates were attached precisely as in *B. naissantii*, one cannot, in the absence of the original specimens, say definitely that this is the case. The scutum, and the upper latus especially—if, indeed, it be an upper latus,—depart widely from the type of valve seen in *B. naissantii*, but I am not at all convinced that they belong to *B. lithotryoides*. Since it is likely, however, that the carina and rostrum (= Bosquet's subrostrum) with the imbricating plates at the base combined to build up a shell in the same way as in *B. naissantii*, the species may be left, at any rate provisionally, in the genus *Brachylepas*.

Type. I have so far been unsuccessful in tracing the type-specimens of this species. Prof. K. Martin, in answer to an enquiry, says that they are not in the Geological Museum of the University of Leyden, and Prof. Eugène Dubois informs us that they are not in Teylers Stichting, Haarlem. I select the original of Bosquet's figure 6 *a-c*, a carina, as the holotype.

Distribution. Maestrichtian: between Vilt and Sibbe, Nédercanne, Bémelen, Geulhem, and at St. Pierre, Duchy of Limbourg, Holland.

Measurements. The carina figured by Bosquet (pl. iii. fig. 6 *a-d*) appears to be the largest known valve, and the length of this is given as 13 mm., which apparently includes the imbricating plates at the base.

Family Pollicipedidæ.

PYCNOLEPAS †, gen. nov.

Pollicipeds in which the capitulum is composed of a single whorl of 8 valves, namely, a long and narrow carina, paired scuta, paired upper latera which are long and narrow and overlap the scuta and terga on either side, paired terga, and a rostrum nearly as large as the carina. Peduncular plates large.

Genotype. *Pollicipes rigidus*, J. de C. Sowerby.

Pycnolepas rigidus, J. de C. Sowerby, sp.
(Pl. VII. figs. 15-19; Pl. VIII. figs. 1-4.)

1836. *Pollicipes rigidus*, J. de C. Sowerby, Trans. Geol. Soc. 2nd ser. vol. iv. p. 335, pl. xi. fig. 6*.

† πικνύς = compact.

1851. *Pollicipes rigidus*, J. de C. Sowerby; C. R. Darwin, Pal. Soc. Monogr. Foss. Lepalidæ, p. 73, pl. iv. fig. 7.
1854. *Pollicipes rigidus*, J. de C. Sowerby; C. R. Darwin, Ray Soc. Monogr. Subclass Cirripedia, Balanidae, Synop. et Index Systematicus, p. 638.
1854. *Pollicipes rigidus*, J. de C. Sowerby; J. Morris, Cat. Brit. Foss. 2d ed. p. 96.
1865. *Pollicipes rigidus*, J. de C. Sowerby; J. W. Salter and H. Woodward, Cat. and Chart Foss. Crustacea, p. 27, pl. i. fig. 5.
1877. *Pollicipes rigidus*, J. de C. Sowerby; H. Woodward, Brit. Mus. Cat. Brit. Foss. Crustacea, p. 149.

Diagnosis. Capitular valves transversely ridged and generally longitudinally ridged. Scuta elongately triangular, with the basi-lateral portion produced and a narrow wall-sided ridge curving from the apex to the basi-lateral angle. Terga with the apical portion much curved towards the scuta, and a ridge like that of the scuta curving from the apex to the basal angle. Peduncular plates with an inwardly projecting basal ledge, the inner extremity of which is furnished with a median socket; externally these plates are irregularly ridged longitudinally and transversely.

Distribution. Albian, Gault: Folkestone and Maidstone, Kent; Eastweare Bay, Sussex; Eclaron (Haute-Marne), France. Cenomanian, Cambridge Greensand, near Cambridge. Chalk Marl, near Cambridge.

Type. J. de C. Sowerby founded this species on a scutum and two imperfect carinæ from the Gault of Folkestone, but I do not know what has become of the specimens. I select the scutum as the holotype of the species. Of the three valves figured by Darwin (1851) from the Gault of Folkestone, two, the carina and scutum, are in the Geological Department of the British Museum, registered respectively I. 13643 and I. 13644.

Material. *Pollicipes rigidus* has hitherto been recorded only from the Gault (Albian), at which horizon it is comparatively common, especially at Folkestone. There is in the Geological Department of the British Museum, registered I. 13670, a single scutum from the Gault of Eclaron (Haute-Marne), France; and I have two carinæ from the Cambridge Greensand, as well as some valves from the Chalk Marl (Cenomanian) of Cambridge.

Up to the present only the scutum, tergum, and carina have been described, but we are now able to add considerably to our knowledge of the species by the discovery in the Gault of Folkestone of a rostrum, an upper latus, and 15 plates of the peduncle. A single upper latus (Pl. VII. fig. 17)

and 6 peduncular plates (three figured, Pl. VIII. figs. 1-3), together with a scutum (Pl. VII. fig. 16), were found embedded in a small piece of clay measuring barely 1 cubic inch, and may therefore belong to the same individual. This might also be the case with the rostrum (Pl. VII. fig. 15) and 8 peduncular plates, which were found together in a similar piece of clay. The remaining single peduncular plate was found together with a carina.

It is a very significant fact that these peduncular plates were found on three different occasions, and in association with the other valves of *P. rigidus*, for if there had been a lower series of valves to the capitulum of this species it is extremely unlikely that one would find 15 peduncular plates and not a single example of a valve of a lower whorl. We are therefore led to the conclusion that there was no lower whorl, and that the capitulum of *P. rigidus* was formed of a single whorl of 8 valves.

Measurements. The valves here figured from the Gault of Folkestone measure respectively:—

	Length. mm.	Breadth. mm.
Rostrum	8·9	5·7
Scutum.....	13·0	5·8
Upper latus	5·8	2·7
Tergum.....	11·1	6·7
Carina	14·6	5·6
Peduncular plate (Pl. VIII. fig. 1) ..	1·5	2·4

A further peduncular plate has a length of 1·8 mm. and a breadth of 3·2 mm. Much larger valves are known from the Gault of Folkestone than any of the above, and in the British Museum are four valves with measurements:—

	Length. mm.	Breadth. mm.
Rostrum. I. 13631	15·0	8·8
Scutum. I. 13488	15·2	7·8
Tergum. I. 13486	19·4	10·6
Carina. I. 13639	19·3	7·1

In the Museum of Practical Geology (no. 26854) there is a scutum measuring 18·4 mm. in length and 7·5 mm. in breadth, and this is the largest scutum seen by me.

The valves from the Chalk Marl of Cambridge are rather small, the largest, a scutum (Pl. VIII. fig. 4), being 4·8 mm. long and 2·1 mm. broad.

Description of valves. All the valves of this species are conspicuously marked on their outer surface with sharp, narrow, steep-sided, prominent ridges parallel to the growth-lines, and each of these ridges appears to have been formed at the completion of each period of growth. In some of the specimens from the Albian (Gault) the spaces between the ridges are smooth, and in others they are plainly marked with longitudinal ridges; but, since all the specimens seen from the Cenomanian (Chalk Marl) have longitudinal ridges and the ornament altogether is more pronounced, it seems as if the valves from the Gault with smooth interspaces came from a lower horizon than those with ridged interspaces. All the valves from the Chalk Marl are very much smaller than the valves from the Gault. The following descriptions are based on valves from the Gault of Folkestone, but any distinctive features shown by the valves from the Chalk Marl are pointed out where considered necessary.

Carina (Pl. VII. fig. 19) semicylindrical, widening gradually from the apex to the basal margin, moderately bowed inwards, strongly convex transversely, not carinate, basal margin slightly concave in the middle. Outer surface ornamented with a number of irregularly spaced, raised, and somewhat undulating ridges, which on the extremely narrow parietes are obliquely upturned; in some specimens the spaces between these ridges are smooth, but in others, especially in those from the Chalk Marl, they are plainly marked with longitudinal ridges. The apical half of the valve projected freely, and on the inner surface this part of the valve is marked with growth-lines which extend from the basal angles and meet in an acutely rounded angle on a slight but well-marked median ridge.

Rostrum (Pl. VII. fig. 15) semiconical, smaller and proportionally wider than the carina, widening rapidly from the apex to the basal margin, considerably bowed inwards, strongly convex transversely, basal margin concave. Outer surface ornamented similarly to the carina. The apical half projected freely, and on the inner surface this part is marked with growth-lines which extend from the basal angles and meet below the apex in a wide flatly rounded angle.

Scutum (Pl. VII. fig. 16; Pl. VIII. fig. 4) elongately triangular, with the basi-lateral portion produced, strongly convex transversely, especially in its apical portion, apex acuminate and strongly curved towards the terga; occludent margin strongly convex; basal margin about half the length of the occludent margin, and making with it an angle con-

siderably above a right angle; tergo-lateral margin concave in its upper part, the lower part being rounded and protuberant. Basi-lateral angle somewhat acute, with a slight, narrow, square-edged extension formed by the projection of the ridge extending from the apex to this point; this projection is extremely prominent in the scuta from the Chalk Marl (Pl. VIII. fig. 4). The apico-basal ridge is very conspicuous, being formed of a single ridge in the Gault valves and of two ridges in the Chalk Marl valves, and extends in a strongly curved line from the apex about midway between the outer margins; it is narrow, being usually about half the width of a zone of growth, and has perpendicular sides, or is, as Darwin said, wall-sided; where the transverse ridges cross this ridge it is produced into slight prominences, varying in prominence in different specimens; but in those from the Chalk Marl the ridge is produced into sharp points. A slight ridge extends from the apex near and parallel to the upper part of the tergo-lateral margin, and from this ridge the valve is inwardly rounded. Some valves are ridged longitudinally, and others not, but all those from the Chalk Marl are strongly ridged longitudinally between the transverse ridges. On the inner surface the occludent edge is broad and flat, is widest adjoining the top of the pit for the adductor muscle, being there nearly half the width of the valve, and is marked with growth-lines; a deep triangular furrow, marked with growth lines, lies near the tergal margin, and serves for the reception of the scutal angle of the tergum; just below the furrow and the flat occludent edge there is a deep pit for the adductor muscle.

Tergum (Pl. VII. fig. 18) subrhomboidal, almost flat transversely, with a curved, narrow, wall-sided ridge like that of the scutum, extending from the apex to the basal angle, where it is produced; apical portion much curved towards the scuta. The apico-basal ridge is situated about one-third the width of the valve from the carinal margin, is only very slightly raised where crossed by the transverse ridges, which are not so prominent as on the other valves; in the valves from the Chalk Marl the ridge is produced into prominent sharp points. The upper carinal margin is slightly longer than the lower, and makes with it almost a continuous curve; occludent margin slightly concave, shorter than the scutal margin. A portion of the valve along the occludent margin is rounded and protuberant to the extent to which the valve was overlapped by the scutum; this raised portion is followed by a depression, which is bounded by a slight but

distinct ridge which extends from the apex to about the middle of the scutal margin. On the inner surface the upper carinal edge is flat and wide, and the inner occludent edge is rounded and narrower, both edges being marked with growth-lines.

Upper latus (Pl. VII. fig. 17) a very acute-angled isosceles triangle. External surface marked with irregularly spaced, slightly undulating, transverse ridges, slightly upturned at the lateral margins, and in the single valve seen there are feebly marked longitudinal ridges. The growth-lines are continued on the inner surface, where they are obliquely upturned, and meet in a raised, sharp-edged, median ridge, which extends to the apex. The portion marked with growth-lines overlapped the scuta and terga on either side, the smooth triangular portion being covered by the corium or membrane lining the inside of the valves.

Peduncular plates (Pl. VIII. figs. 1-3). There are fifteen examples known, and, although of different sizes, all are of the same type. They have a longitudinally ridged outer wall, with from two to three prominent transverse ridges, and an inwardly projecting basal ledge, on the inner extremity of which is a deep, median, elliptical socket; the base of the inwardly projecting portion is concave. Except for this socket they agree well with some peduncular plates that appear to belong to the species *Pollicipes glaber*, F. A. Roemer.

Pycnolepas fallax, Darwin, sp.

(Pl. VII. figs. 10-14; Pl. VIII. fig. 5.)

1850. *Pollicipes maximus*, Sowerby; R. Kner, Haidinger's Naturw. Abhandl. Bd. iii. Abth. 2, p. 35, pl. v. fig. 12.
 1850. *Pollicipes glaber*, F. A. Roemer; A. Alth, Haidinger's Naturw. Abhandl. Bd. iii. Abth. 2, p. 198, pl. x. fig. 20.
 ? 1850. *Pollicipes rigidus*, J. de C. Sowerby; H. B. Geinitz, Das Quadersandsteingebirge, p. 102, pl. ii. figs. 8 a-c.
 1851. *Pollicipes fallax*, Darwin, Pal. Soc. Monogr. Foss. Lepadidæ, p. 75, pl. iv. fig. 8.
 1854. *Pollicipes fallax*, Darwin, Ray Soc. Monogr. Subclass Cirripedia, Balanidæ, Synop. et Index Systematicus, p. 638.
 1854. *Pollicipes fallax*, Darwin; J. Morris, Cat. Brit. Foss. 2nd ed. p. 96.
 1857. *Mitella fallax*, Darwin, sp.; J. Bosquet, Notice sur quelques Cirripèdes Terrain Crétacé Duché de Limbourg, p. 17, pl. ii. figs. 1-7 (non pl. ii. figs. 8-12, pl. iii. figs. 1, 2).
 1864. *Pollicipes fallax*, Darwin; A. Reuss, Sitz. d. K. Akad. Wiss. Wien, vol. xlix. Abth. i. p. 240, pl. iii. figs. 1-6 (? non figs. 12-15).
 1877. *Pollicipes fallax*, Darwin; H. Woodward, Brit. Mus. Cat. Brit. Foss. Crustacea, p. 140.
 1880. *Pollicipes fallax*, Darwin; Th. Marsson, Mittheil. naturw. Ver. Neu-Vorpommern und Rügen, xii. p. 20 (non pl. ii. fig. 6).

1886. *Pollicipes fallax*, Darwin; J. Kafka, Sitz.-Ber. k. Böhm. Gesell. Wiss. Prag (1885), p. 571, pl. iii. figs. 2, 3 (partim).
 1887. *Pollicipes fallax*, Darwin; A. J. Fritsch and J. Kafka, Crust. Böhmischen Kreidef. p. 10, fig. 17 (partim).
 1888. *Mitella fallax*, Darwin, sp.; A. Peron, Bull. Soc. Sci. Yonne, vol. xli. (1887) p. 267, pl. iii. figs. 5-9.
 1893. *Pollicipes fallax*, Darwin; A. Fritsch, Arch. naturw. Landesd. Böhmen, Prague, vol. ix. p. 108, fig. 143.
 1902. *Pollicipes fallax*, Darwin; A. Wolleman, Abh. k. preuss. geol. Landesanst. N. F. Heft 37, p. 115.
 1906. *Brachylepas fallax*, Darwin, sp.; H. Woodward, Geol. Mag. dec. v. vol. iii. p. 340, figs. 5-18, 21-22, 24 (non figs. 19, 20, 23).
 1912. *Pollicipes fallax*, Darwin; T. H. Withers, "Cirripedes in the Norwich Museum from the Norfolk Chalk, studied by Darwin," Trans. Norfolk and Norwich Nat. Soc. vol. ix. p. 309.

Diagnosis. Capitular valves ridged transversely, but not longitudinally, or at least very weakly so. Scuta elongately triangular, with a ridge with sloping sides curving from the apex to the basi-lateral angle. Terga with a similar ridge curving from the apex to the basal angle.

Distribution. Upper Senonian, *B. mucronata*-zone: Norwich and Trimmingham, Norfolk; Clarendon, near Salisbury, Wilts; I. of Rugen; Lüneburg, Hanover. *A. quadratus*-zone: East Harnham, near Salisbury, Wilts; Reims, France. *M. coranguinum*-zone: Quidhampton, near Salisbury, Wilts. Upper Senonian: Gehrden, Hanover; ? Plauen, near Dresden; Ciplu and Heure-le-Romain, Belgium; Nagorzani, Galicia; near Lhota Úřetická, and Chotzen, Bohemia; Balsberg and Köpinge, Seania.

Type. Of this species Darwin had only scuta and terga; his figured types*, the scutum and tergum from the Chalk of Norwich, are in the Norwich Museum, registered respectively 2153 (lectoholotype), 2153 c.

Material. Further valves, coming from different horizons, have been made known by later authors, but we are indebted more particularly to Bosquet (1857) and H. Woodward (1906) for our knowledge of the species, especially since the valves figured by them are from one horizon.

So far it can be proved that *P. fallax* had a rostrum, paired scuta, paired upper latera, paired terga, and a carina, and all these valves are of the same general type as in *Brachylepas*, except that the carina and rostrum are longer and narrower, just as in the other species included in the new genus *Pycnolepas*; the arrangement of the valves is

* See T. H. Withers, 1912, Norfolk and Norwich Nat. Soc. vol. ix. p. 309.

precisely the same. As to the remaining valves that have been attributed to this species, it is extremely doubtful whether they really belong to it, and, in view of the relationship of this species to *P. rigidus*, there is good reason to believe that it had no lower whorl of valves.

Bosquet (1857) figured as belonging to this species a scutum, tergum, carina, rostrum, subcarina, subrostrum, an upper latus, and seven valves of the lower whorl. H. Woodward (1906) figured corresponding valves, with the exception of the subcarina, but with the addition of two carinal latera, all the valves having been found together in a large pyramidal flint. He referred the species to his genus *Brachylepas*.

Through the kindness of Mr. R. M. Brydone, F.G.S., I have been enabled to examine the whole of his Trimmingham specimens of *P. fallax* that were described by Dr. Woodward (1906). In that paper some carinae, rostra, and a supposed subrostrum were figured, but, in my opinion, fig. 8 is a small carina, and not a rostrum, and the valve figured (fig. 10) as a subrostrum is merely a young and smaller example of a rostrum. Among the valves collected by Mr. Brydone there are small carinae, and there is no reason why there should not be correspondingly small rostra. The two carinal latera figured as belonging to *P. fallax* really belong to *Scalpellum*, fig. 19 being a carinal latus of *S. fossula* and fig. 20 being a similar valve of *S. maximum*; and, although the valve represented by fig. 19 was found attached to a carina of *P. fallax*, it certainly does not belong to that species. It is of almost the same length as the carina, and is consequently much too large to have belonged to the same individual, as suggested by Dr. Woodward, even if it were a valve of the same species. Of the lower latera figured by Dr. Woodward, that in the upper figure (fig. 23) agrees very well with the imbricating plates in *Brachylepas naissantii*, and probably belongs to that species; but the lower figure (fig. 24) represents only the broken apical portion of a rostrum of *P. fallax*, and on the inner surface can be seen the flatly rounded growth-lines typical of the rostrum of *P. fallax* and allied species, the growth-lines indicating the free projection of the apex.

In identifying these valves and referring them to *Brachylepas* Dr. Woodward evidently overlooked the fact that in the type-species there is no subrostrum, and that in his restoration there is no place for such valves or for the comparatively large carinal latera.

With regard to the so-called subcarinæ and subrostra figured by Bosquet (1857), it is highly probable that they also are small examples of carinæ and rostra, and the seven supposed lower lateral plates, of which two show exteriorly a median basal notch, may be referred with more justification to Bosquet's species *Brachylepas lithotryoides*.

There is also much uncertainty with regard to the valves considered by other authors to belong to the lower whorl of *P. fallax*, and, in fact, there is no real evidence that *P. fallax* had a lower whorl of valves, for in the absence of any lower lateral plates one cannot quite see how this species could have had subrostra and subcarina.

Therefore, in default of more precise evidence to the contrary, I prefer to include *Pollicipes fallax* in the new genus *Pycnolepas*, with which it more closely agrees.

According to Mr. Brydone, *P. fallax* is by far the commonest of the Cirripedes in the Trimmingham Chalk. It is met with occasionally in the *mucronata*-zone of Norwich, and Dr. H. P. Blackmore has collected in the neighbourhood of Salisbury a single carina and rostrum from the *mucronata*-zone and a single rostrum from the *quadratus*-zone. The most interesting specimen, one which constitutes the earliest record for this species, is a beautifully preserved rostrum (Pl. VIII. fig. 5) obtained by Dr. Blackmore from the base of the upper third of the *M. coranguinum*-zone at Quidhampton, near Salisbury. Although this valve has a median ridge and is so much incurved that I think it must be a rostrum, it certainly is comparatively narrow for such a valve. It has a rather different appearance, owing to its being more strongly and irregularly ridged than the valves from higher horizons.

Measurements. The valves figured in this paper (Pl. VII. figs. 10-14) measure respectively:—

	Length.	Breadth.
	mm.	mm.
Rostrum.....	14·1	9·2
Scutum.....	18·0	9·2
Upper latus.....	12·5	2·8
Tergum.....	15·8	10·8
Carina.....	17·4	6·5
? Rostrum (Pl. VIII. fig. 5).....	7·7	3·7

Only two valves are known to me from the English Chalk that exceed the above in size, and these are a tergum from the Trimmingham Chalk, said by Dr. Woodward (1906, p. 345) to be 19 mm. long and 11·5 mm. broad, and a carina in the

Norwich Museum (2156 *b*) measuring 22.1 mm. in length and 7.4 mm. in breadth. These measurements, however, are exceeded by two valves in the Geological Department of the British Museum, said to be (H. Woodward, 1906, p. 341) probably from the Ober Quader of Plauen, near Dresden. They are:—

	Length.	Breadth.
	mm.	mm.
Scutum (I. 14050)	20.2	10.7
Tergum (I. 14052)	23.1	10.0

Description of valves. In this species the valves are moderately thick and conspicuously marked externally with rather wide, prominent, transverse ridges, which terminate each zone of growth, but the valves are not ridged longitudinally, or at least only weakly so. The transverse ridges are more prominent at the occludent margins of the scuta and terga and on the lateral margins of the other valves.

Carina (Pl. VII. fig. 14) semicylindrical, slightly or moderately bowed inwards, strongly convex transversely, not carinate; basal margin somewhat concave. Outer surface ornamented with a number of strong but somewhat flattened ridges, which are sometimes fairly regularly spaced, but more often irregularly spaced. The apical half of the valve projected freely, and on the inner surface the freely projecting portion is marked with growth-lines which extend from the basal angles and meet in a flatly rounded angle below the apex.

Rostrum (Pl. VII. fig. 10) semiconical, smaller and proportionally wider than the carina, usually considerably bowed inwards, strongly convex transversely, with a median keel feebly marked in some specimens, but not apparent in others; basal margin concave. Ornamented externally like the carina. The valve projected freely to nearly half of its extent, and on the inner surface this portion is marked with growth-lines, which extend from the basal angles, and on reaching about half the length of the valve turn abruptly inwards and downwards, and meet in a concave curve below the apex.

Scutum (Pl. 11. fig. VII) elongately triangular, with the basi-lateral portion slightly produced, moderately convex transversely, apex acuminate and strongly bowed towards the terga; occludent margin strongly convex; basal margin nearly straight, and at the rostral angle making almost a right angle with the lower part of the occludent margin;

tergo-lateral margin usually concave in its upper part, and convex below. The apico-basal ridge is very prominent, rather broad, about as broad as a zone of growth, slightly rounded at its summit, has steeply sloping sides, and extends in a curved line rather nearer to the tergo-lateral margin. Apico-basal ridge not at all produced where crossed by the prominent transverse ridges; the transverse ridges are strongly raised, equally spaced, and bend downwards and are slightly thickened at the occludent margin. A slight ridge can be seen extending from the apex to the tergo-lateral angle, and from this ridge the valve at the upper part of the tergo-lateral margin is inwardly rounded. On the inner surface the occludent edge is much thickened, broad and flat, is widest adjoining the top of the pit for the adductor muscle, being there more than two-thirds the width of the valve; it is marked with growth-lines. The inner margin of the occludent edge is considerably raised and overhangs the subtriangular depression for the reception of the scutal angle of the tergum.

Tergum (Pl. VII. fig. 13) subrhomboidal, somewhat convex transversely, with a curved ridge like that of the scutum, from which the sides of valve slope steeply, extending from the apex to the basal angle, but not projecting beyond it; apical portion of the valve slightly to moderately curved towards the scuta. The apico-basal ridge is situated almost in a median line, and is not produced where crossed by the transverse ridges. Upper carinal margin usually slightly shorter than the lower, both of which meet in a well-defined angle; occludent margin usually shorter than the scutal margin, and of about the same length as the upper carinal margin. A portion of the valve along the occludent margin is rounded and protuberant, and on its inner margin is bounded by a depression; about midway between the depression and the apico-basal ridge, slight indications can be seen in some specimens of an indistinct ridge, evidently homologous with that seen in the terga of *P. rigidus*.

Upper latus (Pl. VII. fig. 12) shaped like a very acute-angled isosceles triangle. External surface marked with several raised, regularly spaced, and prominent transverse ridges, slightly upturned at the lateral margins; the inner lateral margins have a serrated appearance owing to the prominence of these outer ridges. On the inner surface the growth-lines are obliquely upturned, and meet on a very prominently raised, sharp-edged ridge, which extends to the apex from a point just above one-third the length of the valve from the base.

Pycnolepas brünnichi, nom. nov.

(Plate VII. figs. 5-9; Plate VIII. fig. 6.)

1839. *Pollicipes rigidus*, J. de C. Sowerby; J. Steenstrup, Krøyer's Naturhist. Tidsskrift, Bd. ii. p. 404, pl. v. figs. 24-26 (non *P. rigidus*, J. de C. Sowerby, 1836).
1851. *Pollicipes elegans*, C. R. Darwin (non Lesson), Pal. Soc. Monogr. Foss. Lepadidæ, p. 76, pl. iv. fig. 9.
1854. *Pollicipes elegans*, C. R. Darwin, Ray Soc. Monogr. Subclass Cirripedia, Balanidæ, Synop. et Index Systematicus, p. 639.
1857. *Mitella elegans*, C. R. Darwin, sp.; J. Bosquet, Notice sur quelques Cirripèdes dans le Terrain Crétacé du Duché de Limbourg, p. 14, pl. iii. figs. 3 a, b.
1865. *Pollicipes elegans*, C. R. Darwin; J. W. Salter & H. Woodward, Cat. & Chart Foss. Crustacea, p. 27, pl. i. fig. 9.
1912. *Pollicipes elegans*, C. R. Darwin; K. B. Nielsen, Medd. Dansk geol. Foren. Bd. iv. p. 32, pl. i. figs. 18-20, pl. ii. figs. 1-8, 11, 12 (non figs. 9, 10, 13-18).

Diagnosis. Capitular valves transversely and longitudinally ridged. Scuta subtriangular, with a broad wall-sided ridge, sometimes broader than the tergo-lateral portion, curving from the apex to the basi-lateral angle. Terga with the apical portion only slightly curved towards the scuta, and a similar but narrower ridge extending almost straight from the apex to the basal angle.

Distribution. Danian: Faxe, Denmark; Ignaberga, Scania. Maestrichtian: Bémelen, Duchy of Limbourg, Holland, and Ciply, Belgium.

Type. Steenstrup originally described a scutum, tergum, and carina of this species as *Pollicipes rigidus*, J. de C. Sowerby. Darwin subsequently described the species as new, but inadvertently gave it the name *Pollicipes elegans*, already, as he well knew, used by Lesson (1830, "Voyage de la 'Coquille,'" vol. ii. p. 441; 1831, *Illust. Zool.* pl. xxxix.) for a recent species.

Darwin's material consisted of three scuta, a tergum, and two carinae received from Prof. Steenstrup, and of two scuta collected by N. P. Angelin. Since Cirripedes have already been named after both Darwin and Steenstrup, I name this after Dr. K. Brünnich Nielsen, to whom we are indebted for our present knowledge of the species.

Dr. J. P. J. Ravn has most kindly searched among the Steenstrup collection in Copenhagen University, and informs me that he can identify neither the valves figured by Steenstrup as *P. rigidus* nor those figured by Darwin as *P. elegans*. Prof. G. Holm also writes to say that the two scuta mentioned by Darwin as collected by N. P. Angelin are not in the Riksmuseum, Stockholm. They were probably in the Steenstrup collection.

It would have been best, perhaps, to have fixed on one of Darwin's specimens as the holotype of the species, but in view of the fact that all the specimens have been lost sight of, I reluctantly fix on the scutum here figured (Pl. VII. fig. 6) as the holotype.

Material. Only the scutum, tergum, and carina were known to Darwin, but Dr. K. B. Nielsen has collected a large number of valves comprising 74 carinæ and rostra, 129 scuta (81 right and 48 left), 126 terga (64 right and 62 left), and 9 upper latera. Some of these which he figured (1912) include a rostrum and an upper latus. Among them are three peduncular plates, which, however, show no signs of prominent transverse and longitudinal ridges as one would expect them to if they belonged to such a highly ornamented species as *P. brünnichi*; they agree more in their ornament with the valves of the species *Scillælepas dorsata*, to which therefore I refer them. The valve figured as a carinal latus is a rostral latus of *S. dorsata* (see p. 193). Dr. J. P. J. Ravn sent me from the Mineralogical Museum of Copenhagen University the three peduncular plates for examination, but, owing to the fact that the "carinal latus" has been lost, he sent other similar valves determined by Dr. Nielsen, and these without doubt are rostral latera of *S. dorsata*. For the specimens of *P. brünnichi* figured in this paper I am indebted to Dr. Nielsen, as also for 42 carinæ and rostra, 43 scuta, 91 terga, and 3 upper latera.

Although Dr. Nielsen records upwards of 300 valves, not a single valve has been found that could be referred to a lower whorl.

Measurements. This species probably attained nearly to the size of *P. paronai*. To judge from the figures given by Dr. Nielsen, the valves measured:—

		Length.	Breadth.
		mm.	mm.
Rostrum	circa	10·0	5·5
Scutum	"	15·5	7·0
Upper latus	"	6·0	1·5
Tergum	"	15·0	8·0
Carina	"	11·5	4·0

The valves here figured (Pl. VII. figs. 5-9), with the exception of the upper latus, are much smaller than the above. Darwin (1851, p. 76) records a scutum as measuring 1·1 inches in length, which is much larger than that figured by Dr. Nielsen.

Description of Valves. The valves of this species have the ridges terminating each zone of growth much raised and with steeply sloping sides, the longitudinal ridges also being raised and prominent.

Carina (Pl. VII. fig. 9) semicylindrical, widening gradually from the apex to the basal margin, moderately bowed inwards, strongly convex transversely, not carinate, basal margin slightly concave. Outer surface ornamented with a number of prominent transverse ridges crossed by longitudinal ridges, which present a goffered appearance where they meet. The apical portion projected freely for more than a third the length of the valve, and this part is marked with growth-lines, which extend from the basal angles and meet in an acutely rounded angle below the apex; the inner lateral edges are somewhat thickened for about one-fourth the width of the valve.

Rostrum (Pl. VII. fig. 5) semiconical, smaller and proportionally wider than the carina, widening rapidly from the apex to the basal margin, considerably incurved, strongly convex transversely, basal margin slightly convex. Outer surface with ornament similar to that of the carina. The apical half projected freely, and on the inner surface this part is marked with growth-lines that extend from the basal angles and meet in a rounded angle below the apex; the inner lateral edges are somewhat thickened to about one-third the width of the valve.

Scutum (Pl. VII. fig. 6; Pl. VIII. fig. 6) subtriangular, strongly convex transversely, apex acuminate and strongly curved towards the terga; occludent margin usually strongly convex; basal margin almost straight, about half the length of the occludent margin, and making with it an angle slightly above 90° ; tergo-lateral margin usually strongly concave in its upper part, and varying from straight to strongly convex in its lower part, which forms nearly a right angle with the basal margin. Basi-lateral angle generally slightly produced and obliquely truncated, the projection being formed by the apico-basal ridge. This ridge is a conspicuous feature, and extends from the apex in a slightly curved line, much nearer to the tergo-lateral margin. It is much raised, flat-topped, has perpendicular sides, is wider in most valves than a zone of growth, in some much wider, and even wider than the tergo-lateral portion of the valve (see Pl. VIII. fig. 6). It is formed of longitudinal ridges varying in number from two to five. An almost imperceptible ridge extends from the apex almost parallel to the upper part of the tergo-lateral margin, and from this ridge the valve is strongly rounded

inwards. Outer surface ornamented with strongly marked, raised, transverse ridges, crossed by well-marked longitudinal ridges. On the inner surface the occludent edge is very broad and flat, is widest adjoining the pit for the adductor muscle, being more than half the breadth of the valve, and is marked with growth-lines. An elongately-triangular furrow, marked with growth-lines, is situated above the pit for the adductor muscle, and is bounded by the upper part of the inner occludent edge, and this furrow serves for the reception of the scutal angle of the tergum.

Tergum (Pl. VII. fig. 8) subrhomboidal, slightly convex transversely, with an almost straight, wall-sided ridge, much narrower than that of the scutum, extending from the apex to the basal angle, where it is produced and truncated; apical portion scarcely curved towards the scuta. The apico-basal ridge is situated almost centrally, and where crossed by the transverse ridges is produced into sharp points. Upper carinal margin slightly convex, and the occludent margin slightly concave, both being about the same length, and shorter than the lower carinal and scutal margins, which also are of about the same length. A portion of the valve is rounded and protuberant along the occludent margin, to the extent to which the valve was overlapped by the scutum; this rounded margin is followed by a wide depression bounded by a more or less distinct ridge extending from the apex to about the middle of the scutal margin. On the inner surface the upper carinal edge is flat, and the inner occludent edge rounded and narrower, both edges being marked with growth-lines.

The *upper latus* (Pl. VII. fig. 7) has the shape of a very acute-angled isosceles triangle. Externally it is marked with irregular, undulating, raised transverse ridges, abruptly upturned at the outer margins: these ridges are crossed by prominent longitudinal ridges which give to them a goffered appearance. The growth-lines are continued on the inner surface and meet on a raised, sharp-edged, median ridge, which extends to the apex; this ridge fitted between the scuta and terga, the valve on either side overlapping the scutum and tergum, while the smooth triangular part at the base was covered by the corium or membrane lining the inside of the valves.

Pycnolepas paronai, de Alessandri, sp.
(Plate VII. figs. 1-4.)

1895. *Pollicipes paronai*, de Alessandri, Boll. Soc. Geol. Ital. vol. xiii. p. 266, pl. i. figs. 8 a-f.

1906. *Pollicipes paronai*, de Alessandri, Palæont. Ital. vol. xii. p. 248, pl. xiii. figs. 1-9.

Diagnosis. Capitular valves with closely set, somewhat flattened, transverse and longitudinal ridges, the longitudinal ridges on the scuta and terga being fine, wavy, and radiating from the apico-basal ridge. Scuta elongately triangular, with a broad, flattened, steep-sided ridge curving from the apex to the basi-lateral angle. Terga with the apico-basal ridge narrower than that of the scutum, almost straight; the apex not at all incurved.

Distribution. Oligocene (Aquitanian): Chieri, Turin, Italy. Miocene (Helvetian): Colli di Torino, Baldissero, and Sciolze, Turin, Italy.

Type. Prof. G. de Alessandri founded this species on carinæ, scuta, and terga which are in the collection of Count Luigi di Rovasenda, and of these I fix on the scutum (figs. 8 a, b) as the holotype. Prof. de Alessandri subsequently figured similar valves, but among the carinæ included (1906, pl. xiii. fig. 9) a rostrum of the species.

Material. Count Luigi di Rovasenda and Prof. G. de Alessandri kindly sent me the following valves of this species:—3 scuta, 6 terga, and 2 rostra. I am also indebted to Prof. C. F. Parona for allowing me to borrow the two carinæ and the rostrum (figured, Alessandri, 1906, pl. xiii. figs. 7-9) which are in the Geological Museum of the Royal University of Turin.

Measurements. This is the largest species of the genus, and Prof. de Alessandri gives the following measurements for the valves described by him:—

	Length.	Breadth.
	mm.	mm.
Scutum	24·5	13·0
Tergum	29·5	17·0
Carina.....	22·0	10·5

The tergum here figured (Pl. VII. fig. 3), when complete, must have measured at least 30 mm. in length, and its breadth is 19·2 mm. Prof. de Alessandri (1906, pl. xiii. fig. 9) figures a rostrum as a carina, and this valve is 11·2 mm. in length and 7·4 mm. in breadth. The rostrum here figured (Pl. VII. fig. 1) is broken at the apex, but its length must have been at least 17 mm., and its greatest breadth is 9·2 mm., even though the valve is broken at each basal angle.

Description of Valves. In this species the transverse ridges terminating each zone of growth are closely and irregularly

set, and have their edges somewhat rounded and flattened. The longitudinal ridges are also somewhat flattened, and on the scuta and terga have a wavy appearance and radiate from the apico-basal ridge.

Carina (Pl. VII. fig. 4) semicylindrical, widening gradually from the apex to the basal margin, slightly to moderately bowed inwards, strongly convex transversely, not carinate, basal margin almost straight. Outer surface ornamented with a number of prominent, but somewhat flattened transverse ridges, crossed by fine, rounded, closely set, longitudinal ridges. The apical portion projected freely for less than a third of the length of the valve, and the portion is marked with growth-lines which extend from the basal angles and meet in a rounded angle below the apex; the inner lateral edges of the valve are somewhat thickened for about one-fourth the width of the valve.

Rostrum (Pl. VII. fig. 1) semiconical, smaller and proportionally wider than the carina, widening rapidly from the apex to the basal margin, moderately bowed inwards, strongly convex transversely, basal margin concave. Outer surface ornamented similarly to the carina. On the inner surface the lateral edges of the valve are thickened, the median third of the valve forming a deep hollow between; the apical half of the valve projected freely, and this part is marked with growth-lines which extend from the basal angles and meet in a rounded angle below the apex.

Scutum (Pl. VII. fig. 2) elongately triangular, proportionally narrow, almost flat transversely, apical portion much bowed towards the tergum, narrow, and acuminate; occludent margin strongly convex; basal margin less than half the length of the occludent margin, and forming with it an angle slightly less than 90° ; tergo-lateral margin strongly concave in its upper part, its lower part being rounded and somewhat protuberant. Basis-lateral angle, where the apico-basal ridge slightly projects, is obliquely truncated. The apico-basal ridge extends in a strongly curved line from the apex, rather nearer to the tergo-lateral margin; it is flatly rounded transversely, has steep, but not perpendicular sides, and is more than twice as wide as a zone of growth. Along the tergal margin the valve is inwardly rounded, but there does not appear to be any trace of a ridge. Outer surface ornamented with a number of prominent transverse ridges, the interspaces of which are marked with raised transverse lines; the transverse ridges are crossed by fine, wavy, longitudinal ridges radiating from the apico-basal ridge. On the inner

surface the ocludent edge is very broad and flat, and is widest at a point well above the pit for the adductor muscle, where it is more than half the width of the valve; an almost flat triangular portion of the valve near the tergal margin, bounded by the raised inner ocludent edge, is marked with growth-lines, and this part served for the reception of the scutal angle of the tergum; the adductor muscle pit lies below the inner ocludent edge, but above the pit there is a comparatively wide sloping portion of the valve between it and the triangular portion which received the tergum.

Tergum (Pl. VII. fig. 3) subrhomboidal, moderately convex transversely, with a straight steep-sided ridge, much narrower than that of the scutum, extending from the apex to the basal angle, where it is produced; apical portion scarcely curved towards the scuta. The apico-basal ridge is situated rather nearer to the tergal lateral margin, and where crossed by the transverse ridges is somewhat raised. Upper carinal margin convex, nearly straight, and about the same length as the scutal margin; ocludent margin convex and of about the same length as the lower carinal margin. A comparatively wide portion of the valve along the ocludent margin is slightly raised and rounded, and slightly protuberant at the scutal angle; the raised portion is followed by a depression from which the valve rises to meet an indistinct ridge or fold in the valve extending from the apex to about the middle of the scutal margin. On the inner surface a considerable portion of the valve at the inner ocludent and upper carinal edges is flat and marked with growth-lines, the inner ocludent edge being the narrowest.

Upper latus unknown.

Pycnolepas scalaris, sp. n. (Plate VIII. figs. 7-10.)

Diagnosis. Upper whorl of valves transversely and longitudinally ridged; the transverse ridges are produced into sharp spines, where they are crossed by longitudinal ridges. Scutum triangular, with no apico-basal ridge, and growth-lines not upturned on the tergo-lateral half of the valve. Upper latus long and narrow. Tergum unknown.

Material. A right scutum, two rostra, and an upper latus.

Holotype. The rostrum (Pl. VIII. fig. 7).

Horizon and locality. Cenomanian, Chalk Marl: near Cambridge.

Measurements. This species is one of the smallest of the

known fossil Cirripedes, and its valves are most beautifully ornamented. They measure respectively :—

	Length. mm.	Breadth. mm.
Rostrum (holotype)	1·9	1·3
Rostrum.....	1·1	0·8
Scutum	2·0	1·3
Upper latus	2·4	1·2

Description of Valves. *Scutum* (Pl. VIII. fig. 10) triangular, slightly convex; apical portion inclined from the opposing scutum, acute, and curved towards the terga. Basal margin almost straight; ocludent margin convex; tergal margin concave. Outer surface ornamented with fine transverse ridges which are not upturned on the tergo-lateral half of the valve. Where the transverse ridges are crossed by the longitudinal ridges, they are produced into short sharp spines, which project outwards but not across the transverse ridges. On the inner surface is a shallow pit for the adductor muscle.

Rostrum (Pl. VIII. fig. 7) semiconical, slightly bowed inwards, basal margin semicircular, somewhat concave. Inner surface thickened near the inner margins, and marked by growth-lines which are continued under the apex to nearly half the extent of the valve. Outer surface ornamented with transverse ridges. On the larger specimen these ridges are crossed by about seven longitudinal ridges, and are there produced into short spines, similar to, but more pronounced than, those on the scutum. Two of the longitudinal ridges, which occupy a submedian position, are much thicker than the others. On the smaller example the longitudinal ridges are not so apparent.

Upper latus (Pl. VIII. fig. 9) a very acute-angled isosceles triangle, slightly bowed inwards. The outer surface is ornamented with prominent transverse ridges which bear short spines arranged in longitudinal rows, and these spines are evidently produced by longitudinal ridges crossing the transverse ridges as in the other valves. Except for two strong ridges in a median position, the longitudinal ridges are not apparent between the transverse ridges. On the inner surface the growth-lines meet on a raised, sharp-edged, median ridge, which extends from about the middle of the valve to the apex. The valve therefore overlapped the scuta and terga to about half of its extent.

Structure and Affinities. This species is referred to the genus *Pycnolepas* with some doubt, for, although the rostrum

and upper latus are of the same type as those of the other species of the genus, the scutum is quite unlike that of any of them; the tergum is not known. In the scutum there is no prominent apico-basal ridge, and the growth-lines do not differentiate the ocludent portion from the tergo-lateral portion as in the other species. In fact, if the ornamentation had not been so strikingly similar to that of the other valves, one would doubt its belonging to the same species. Some hundreds of separate valves of different species have been obtained from the Chalk Marl of Cambridge, but none have been found to agree in ornament except the above valves, so the probability is that, despite the different form of the scutum, all these valves belong to the same species. In form the scutum approaches that referred by Bosquet to his *Brachylepas lithotryoides*, but in that species the valve is comparatively thick and massive, is quite different in the structure of its inner surface, and can readily be distinguished by its flat and coarse longitudinal ridges. The rostrum and upper latera are similar in form to those of *P. rigidus*, *P. brünnichi*, and *P. parouai*, but can be distinguished by the much more widely-spaced longitudinal ridges, and the spinose appearance of the valves.

Structure of the Species of Pycnolepas.

In my paper on "*Brachylepas cretacea*" (Geol. Mag. 1912), the species *Pollicipes fallax*, Darwin, which had been referred by Dr. H. Woodward to his genus *Brachylepas*, was left out of consideration. This was done chiefly because it seemed probable that to whatever genus *P. fallax*, Darwin, belonged, the species *Pollicipes parouai*, Alessandri, *P. elegans*, Darwin (= *P. brünnichi*), and *P. rigidus*, J. de C. Sowerby, belonged also. An examination of the known valves of these three species seemed to show that they were related in form, structure, and disposition, and were precisely similar to the corresponding valves in *P. fallax*.

P. parouai, *P. elegans*, and *P. rigidus* were represented by carinae, scuta, and terga, and if similarity in shape and structure were criteria, one would expect to find that these three species had a large rostrum and a long and narrow upper latus, as in *P. fallax*. This conclusion, strengthened by the fact that *P. rigidus* occurred in the Gault clay, made it seem advisable to wash such material as could be obtained, in the hope of finding the rostrum and upper latus of *P. rigidus*, and these valves were eventually found and proved to be similar in shape to those of *P. fallax*. Now

that the rostrum of *P. rigidus* is known, it is easy to see that some of the valves of this species, hitherto considered to be smaller and wider carinæ, are really rostra; several specimens are in the Geological Department of the British Museum. With regard to *P. paronai*, it is clear to me, from an examination of the specimen, that the valve figured by Prof. G. de Alessandri (1906, Palæontogr. Ital. vol. xii. pl. xiii. fig. 9) as a carina of *P. paronai* is not a carina but a rostrum. A further specimen, which leaves no doubt as to its being a rostrum, was among the valves given to me by Count Luigi di Rovasenda; it is particularly like that of *P. rigidus*, and agrees in being wider in proportion to its length than is the carina. Up to the present, however, the upper latus of *P. paronai* has not been found.

There remained, then, *P. elegans*, Darwin, in which the carina, scutum, and tergum only were known, but Dr. K. Brünnich Nielsen has since figured (1912, Meddel. Dansk geol. Foren. Bd. iv. p. 32, pl. ii. figs. 1-3, 11-12) a rostrum and an upper latus of *P. elegans* similar in shape to those of *P. fallax*, *P. rigidus*, and *P. paronai*.

It is therefore proved that in *P. fallax*, *P. rigidus*, *P. elegans*, and, except for the missing upper latus, in *P. paronai* also, the capitular valves agree in number, structure, and disposition.

The most important evidence, however, in connection with these species is afforded by the 15 peduncular plates that were found on three different occasions with valves of *P. rigidus*, and undoubtedly belong to that species. The circumstances in which these plates were found (see p. 172) justify the conclusion that in *P. rigidus*, and by inference in *P. fallax*, *P. elegans*, and *P. paronai*, there were only 8 valves to form the capitulum, and that the peduncle was formed of plates similar to those of *P. rigidus* here figured.

In support of this conclusion, it should be borne in mind that only the smaller examples of carinæ and rostra of *P. fallax* have been mistaken for subcarinæ and subrostra, and therefore elements of a lower whorl; no lower lateral plates have ever been found to substantiate the claim that that species had a lower whorl. It is also of significance that among upwards of 300 valves of *P. elegans*, as has already been pointed out, there was found not a single valve of a lower whorl.

Moreover, no valves of a lower whorl of *P. paronai* have been found. This is the largest species of the genus, the terga attaining nearly $1\frac{1}{4}$ inches in length, and if lower lateral plates had been present they would have been com-

paratively large and less likely to be overlooked. It is true that the upper latus of *P. paronai* has not yet been found, but this probably being long and narrow would be more liable to fracture. Most of the valves of this species are much fractured.

The capitular valves of *Pycnolepas* agree with those of *Brachylepas* in number and disposition, but differ in the far less width of the carina and rostrum. The main difference from *Brachylepas* lies in the plates of the peduncle, for these are all of one type, and could not have formed a series of whorls as in *Brachylepas*. In any case there is a great structural difference from *Brachylepas*, and since the species differ from those of the typical *Pollicipes* in the small number of valves to the capitulum, they are placed in a new genus *Pycnolepas*.

With respect to the scuta, *P. rigidus* is distinguished by the narrow, wall-sided, apico-basal ridge and in the production of the basi-lateral portion of the valve. *P. fallax* is readily distinguished by the apico-basal ridge having a sharp edge with sloping sides, as well as by the absence of longitudinal ridges. *P. paronai* and *P. brünnichi* both have a very broad apico-basal ridge, but while in *P. brünnichi* it is much raised, flat-topped, and with perpendicular sides, in *P. paronai* it is flatly rounded. The scutum of *P. paronai* is further distinguished by the wavy longitudinal ridges radiating from the apico-basal ridge, and that of *P. brünnichi* in being less elongate than that of the other species.

In the terga *P. fallax* is at once distinguished by the apico-basal ridge having sloping sides: this ridge in *P. rigidus* is narrow and has perpendicular sides; in *P. paronai* it is only slightly broader than in *P. rigidus*, but the valve can be distinguished by the straightness of the ridge. *P. paronai* differs from *P. brünnichi* in the presence of wavy longitudinal ridges radiating from the apico-basal ridge.

Seguenza (1876, Atti Accad. Pontaniana, vol. x. p. 395) doubtfully referred *Pollicipes rigidus* and *P. elegans* (= *P. brünnichi*), together with *P. gracilis*, *P. validus*, and *P. dorsatus*, to his genus *Scillælepas*. Alessandri, however (1906, Paleont. Ital. vol. xii. pp. 249, 264), judging mainly by the form of the scuta, considered that *P. elegans* and *P. rigidus* could not be referred to *Scillælepas*, but that they agreed much more closely in the form of the scuta with *Pollicipes*. He therefore referred the species *P. rigidus* and *P. elegans*, together with *P. fallax* and *P. paronai*, which have a precisely similar form of scutum, to the genus *Pollicipes*. In *Scillælepas* the upper whorl consists of 5 valves, namely, carina,

paired scuta, and paired terga. The subsequent discovery, therefore, of the upper latera in the species *P. jallax*, *P. elegans*, *P. rigidus*, as well as a large rostrum in those species and in *P. paronai*, shows quite conclusively that they cannot be referred to *Scillælepas*. These species, for reasons previously given, are now referred to the new genus *Pycnolepas*. *Pollicipes dorsatus*, which was tentatively referred to *Scillælepas* by Seguenza, is now definitely proved to belong to it (see p. 198), and since *P. validus* is evidently an allied form, there now seems to be more justification for its reference to *Scillælepas*. *P. gracilis* is regarded as a synonym of *P. validus*.

Genus CALANTICA.

1875. *Calantica*, Gray, Annals of Philosophy (n. s.), vol. x. p. 101.
 1907. *Calantica*, Pilsbry, Bull. U.S. Nat. Mus. no. 60, p. 8.
 1908. *Calantica*, Pilsbry, Proc. Acad. Nat. Sci. Philadelphia, p. 106.
 1913. *Calantica*, Withers, Proc. Zool. Soc. London, p. 942.

Capitulum with two whorls of valves, the upper comprising paired scuta, terga, and a carina, the terga occupying the whole of the space between the scuta and carina; lower whorl comprising three pairs of latera, a rostrum, and a sub-carina. Umbo in all valves apical.

The Oriental group, called by Pilsbry (1908), *Calantica*, s. str., has the lower whorl low and wide, small, not concealing the bases of the valves of the upper whorl.

Subgenus SCILLÆLEPAS.

1876. *Scillælepas*, Seguenza, Atti Accad. Pontaniana, vol. x. p. 390.
 1907. *Scillælepas*, Pilsbry, Bull. U.S. Nat. Mus. no. 60, p. 9.
 1908. *Scillælepas*, Pilsbry, Proc. Acad. Nat. Sci. Philadelphia, p. 106.

Valves of the lower whorl large, high, and incurved, and overlapping the bases of the valves of the lower whorl. Umbo in all valves apical.

Calantica (Scillælepas) dorsata, Steenstrup, sp. (Plate VIII. figs. 12-23.)

1839. *Pollicipes dorsatus*, J. Steenstrup, Krøyer's Naturhist. Tidsskrift, Bd. ii. p. 411, pl. v. fig. 27.
 1839. *Pollicipes validus*, J. Steenstrup, *tom. cit.* p. 412, pl. v. fig. 30.
 1851. *Pollicipes dorsatus*, J. Steenstrup; C. R. Darwin, Pal. Soc. Monogr. Foss. Lepadidæ, p. 69, pl. iv. figs. 4 a-f.
 1854. *Pollicipes dorsatus*, J. Steenstrup; C. R. Darwin, Ray Soc. Monogr. Subclass Cirripedia, Balanidæ, Synop. et Index Systematicus, p. 638.

1912. *Pollicipes dorsatus*, J. Steenstrup; K. B. Nielsen, Cirripedierne i Danmarks Danien-Alejringer, Meddel. Dansk. geol. Foren. Bd. iv. Heft i. p. 30, pl. i. figs. 1-13, 17 (non figs. 14-16).
 1912. *Pollicipes elegans*, Darwin; K. B. Nielsen, *tom. cit.* p. 32, pl. ii. figs. 9, 10.

Diagnosis. Valves smooth, strong, and thick. Scuta approaching in shape an equilateral triangle; ocludent margin exteriorly thickened to form a rounded ridge; basilateral angle widely truncated, equalling half the length of the basal margin; tergo-lateral portion, formed by the upturned growth-lines, extremely narrow. Terga with a straight wide ridge, with steep sides, extending from the apex to the basal angle, which on the scutal side is obliquely truncated. Valves of lower whorl large, subtriangular, high, and incurved.

Distribution. Danian: Faxe, Denmark.

Type. Steenstrup (1839) originally founded this species on a tergum, but included in his *Pollicipes validus* a scutum of the species. Darwin (1851) subsequently figured a scutum, tergum, and carina. All the foregoing specimens should be in the University of Copenhagen, but at present only the carina figured by Darwin (1851, pl. iv. figs. 4 a-c) can be identified, and this is in the Mineralogical Museum.

Material. Dr. K. Brünnich Nielsen has recently collected a number of valves of this species, comprising 18 carinae, 48 scuta, 44 terga, and 37 valves of the lower whorl. Of these he figured (1912) a scutum, tergum, and a carina, together with certain valves of the lower whorl. He included with the latter a carinal latus of a *Scalpellum* (pl. i. figs. 14-16), under *P. elegans* a rostral latus of *P. dorsatus* (pl. ii. figs. 9, 10), and (pl. ii. figs. 13-18) some peduncular plates which I believe to belong to *P. dorsatus*, since they agree more with the ornament of the valves of that species. Through the kindness of Dr. J. P. J. Ravn, I have been able to examine the valves of this species figured by Dr. K. B. Nielsen, together with a series of valves of the lower whorl, all of which are in the Mineralogical Museum of the University of Copenhagen. A further series of seven valves of the lower whorl has been presented by the Copenhagen University to the Geological Department of the British Museum, and these are registered I. 15868-I. 15874. For the specimens here figured, I am indebted to Dr. K. B. Nielsen, as well as for a carina, 3 scuta, 2 terga, and a subcarina.

Measurements. This is a comparatively large species, and,
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to judge from the length of the valves known to me, the capitulum must have attained a length of at least 35 mm. Dr. Brünnich Nielsen (1912, pl. i. fig. 12) gives a figure of a tergum, which measures 30 mm. in length, although the apex of the specimen is slightly broken, and his scutum (pl. i. figs. 4-5) has a length of 19.7 mm. The carina here figured (Pl. VIII. fig. 12) would, if complete, measure quite 30 mm. (it now measures 27 mm.). The valves of the lower whorl and the larger of the peduncular plates here figured (Pl. VIII. figs. 16-23) measure respectively:—

	Length.	Breadth.
	mm.	mm.
Rostrum.....	4.2	3.9
Rostral latus (right).....	3.7	5.0
Median latus.....	3.8	4.3
Subcarina.....	2.6	3.4
Carinal latus.....	2.3	2.5
Peduncular plate.....	1.7	1.1

The largest rostral latus is that figured by Dr. Nielsen (1912, pl. i. figs. 6-8) as a carinal latus, which has a length of 5 mm. and a breadth of 8.5 mm.

Scutum (Pl. VIII. figs. 14, 15) triangular, with the basi-lateral angle widely truncated, considerably convex, breadth about three-quarters the length, apex acute, and only slightly curved towards the terga. Occludent margin slightly convex, forming rather less than a right angle with the slightly convex basal margin. Tergo-lateral margin usually slightly concave; a narrow slip is formed along it by the upturned growth-lines, and this is abruptly bent inwards, the inner margin of it forming a sharp ridge on the inner surface. The margin of the truncated basi-lateral angle is almost half the width of the basal margin in the larger valves. Along the occludent margin a narrow portion of the valve is raised to form a rounded ridge, and two further ridges extend from the apex—one to a point about midway on the basal margin, and the other, which is rather less pronounced, to the lowest point of the truncated basi-lateral angle. On the inner surface there is a deep pit for the adductor muscle; the inner inturned tergal edge is concave, and evidently served for the reception of the tergum; the inner occludent edge is of the same width throughout. Above the pit for the adductor muscle, there is a triangular depression, bounded by the inner edges of the tergal and occludent margins.

Tergum (Pl. VIII. fig. 13) subrhomboidal, elongate, moderately convex transversely; ocludent and upper carinal margins forming together less than a right angle, and they are about half the length of the lower carinal and scutal margins. A flat-topped ridge, much steeper on the carinal side, extends in an almost straight line from the apex, widens considerably towards the basal margin, and its obliquely truncated extremity is almost parallel to the upper carinal margin.

Carina (Pl. VIII. fig. 12) much elongated, slightly bowed inwards or outwards, flatly arched transversely, obscurely carinate, with its basal margin almost rectangular. The apical half of the valve is much thickened, and its inner portion is flat and in line with the lateral margins; a comparatively wide portion of the lower part of the valve at the inner margins is marked with growth-lines, showing that the valve overlapped the terga to some extent.

Rostrum (Pl. VIII. fig. 18) triangular, not quite so wide as high, strongly convex transversely, with the apical half strongly incurved, and a wide, prominent, rounded, median ridge extending from the apex to the slightly convex basal margin, where it is slightly produced. On the inner surface there is a central depression evidently serving for the reception of the rostral angles of the scuta; and a slight ridge extends from each lateral angle to a point about one-third of the length of the valve from the apex, and above this ridge the valve is marked by growth-lines, which show that the valve overlapped the scuta to some extent.

Rostral latus (Pl. VIII. figs. 17, 19) obliquely triangular, about one and a half times as wide as high, strongly convex transversely, with the apical half strongly incurved, basal margin concave in the middle. On the inner surface a well-defined ridge extends from the apex to about half the length of the valve, and is there met by two further ridges extending from each basi-lateral angle; the valve is thus divided into three almost equal portions, of which the basal one is smooth, and the two upper portions are marked with growth-lines and must have overlapped the rostrum and median latus respectively.

Median latus (Pl. VIII. fig. 20) obliquely triangular, slightly wider than high, almost flat transversely, with the apical portion very slightly incurved, and the lateral margins somewhat raised to form flat-topped ridges. On the inner surface the valve is divided off by ridges, as is the rostrum, except that the median ridge extends only one-third the

length of the valve from the apex; the inner portions of the valve are much less concave than in the rostrum.

Carinal latus (Pl. VIII. fig. 16) obliquely triangular, almost flat transversely, with a strong median ridge extending from the apex to the basal margin, apical portion slightly incurved, basal margin convex. On the inner surface a ridge extends from each basi-lateral angle to a point slightly over one-third the length of the valve from the apex, and above this ridge the growth-lines meet on a median ridge which is more strongly marked in this valve than in the other basal latera.

Subcarina (Pl. VIII. fig. 21) triangular, almost symmetrical, without a median keel, not so strongly convex transversely as the rostrum, somewhat constricted near the middle, with the apical portion incurved and the basal margin straight. On the inner surface a slight ridge extends from the apex to a point nearly one-half the length of the valve from the apex, and then to each basi-lateral angle. The upper portions marked with growth-lines must have overlapped each carinal latus.

Peduncular plates (Pl. VIII. figs. 22, 23). These are sub-triangular, with rounded apex and rounded basal margin; slightly convex transversely, and slightly incurved. Outer surface smooth, except for a few flatly rounded, transverse ridges. On the inner surface the lower part of the valve is smooth to a varying extent, the upper portion being marked with growth-lines, showing that this part of the plate overlapped the contiguous plates.

Calantica (Scillelepas) valida, Steenstrup, sp.
(Plate VIII. fig. 11.)

1799. Bec de Sèche (*Loligo calmar*), Faujas de Saint-Fond, B., Histoire naturelle de la montagne de St. Pierre, p. 112, pl. xix. fig. 1.
1802. Bek van *Loligo calmar* (maar van eene onbekende soort), Traduction Hollandaise de Faujas par Pasteur, Natuurlijke Histoire van den St. Pietersberg, p. 150, pl. xix. fig. 1.
1839. *Pollicipes validus*, J. Steenstrup, Krøyer's Naturhist. Tidsskrift, Bd. ii. p. 412, pl. v. figs. 28, 29, 29*, 31, 32 (non fig. 30).
1841. *Pollicipes gracilis*, F. A. Roemer; Norddeutschen Kreidegeb. p. 104, pl. xvi. fig. 14.
1850. *Pollicipes gracilis*, Roemer; H. B. Geinitz, Das Quadersandsteingeb. p. 100.
1851. *Pollicipes validus*, Steenstrup; C. R. Darwin, Pal. Soc. Monogr. Foss. Lepadidæ, p. 68, pl. iv. fig. 2.
1851. *Pollicipes gracilis*, F. A. Roemer; C. R. Darwin, *tom. cit.* p. 69, pl. iv. fig. 3.

1854. *Pollicipes validus*, Steenstrup; C. R. Darwin, Ray Soc. Monogr. Subclass Cirripedia, Balanidæ, Synop. et Index Systematicus, p. 637.

1854. *Mitella valida*, Steenstrup, sp.; J. Bosquet, Monogr. Crust. Foss. du Duché de Limbourg, p. 24, pl. ii. figs. 1-3.

Diagnosis. Valves strong, the scuta and carina being extremely thick. Scutum elongate and strongly bent towards the terga, with a ridge extending from the apex to a point on the basal margin rather nearer to the rostral angle; ocludent margin much thickened, and at the rostral angle the valve is produced into a short blunt tooth. Carina steeply arched transversely, the greater part projecting freely, and on the inner side either flat or with a prominent central crest.

Distribution. Danian: Scania, Sweden. Maestrichtian: Petersburg, near Maestricht. Upper Senonian: Cibly, Belgium.

Type. This species was founded by Steenstrup (1839) on some carinæ and scuta from Scania, Sweden, but among them he figured (pl. v. fig. 30) a scutum of *Pollicipes dorsatus*. Some of Steenstrup's specimens are preserved in the University of Copenhagen, the carina (pl. v. fig. 29) being in the Zoological Museum, and the two scuta (pl. v. figs. 31-32) in the Mineralogical Museum. I select the original of fig. 32 as the holotype. Darwin (1851) subsequently figured a carina and two scuta, and of these the carina (pl. iv. figs. 2*a-d*) is in the Zoological Museum, and the scutum (pl. iv. figs. 2*e-f*) is in the Mineralogical Museum, of the University of Copenhagen. Bosquet (1854) also figured a scutum and carina, with the addition of a tergum, but I do not know where these specimens are.

Among the Cirripede valves from Cibly (Belgium) in the Geological Department of the British Museum is a rostrum, registered 38460, which must, I think, belong to this species. It differs much from that of *P. dorsatus*, especially in having the basal margin acutely rounded, and, since the upper margins make a more obtuse angle than in that species, the whole valve approaches more closely to a diamond shape. The ridge extending from below the apex to the lateral angles on the inner surface differs from that of *P. dorsatus* in being much less angular. It is quite possible that this rostrum may belong to some other species, but in the absence of any definite evidence I refer it to *P. validus*.

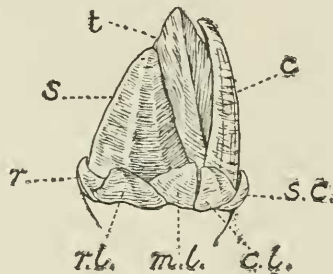
Measurements. This rostrum is 7.9 mm. long, and its breadth is 7.7 mm.

Description.—*Rostrum* (Pl. VIII. fig. 11) subtriangular, basal margin acutely rounded, breadth almost equalling the length, strongly convex transversely, with the apical portion moderately incurved, and a wide, but not very prominent, rounded, median ridge extending from the apex to the basal margin. On the inner surface a gently rounded, delicate ridge extends from the lateral angles to a point nearly one-third the length of the valve from the apex; the portion of the valve above this ridge must have projected freely, but it is not perceptibly thickened, and the growth-lines are not apparent.

*Structure and Affinities of Scillælepas dorsata
and S. valida.*

So long as the species *Pollicipes dorsatus* and *P. validus* of Steenstrup were known only by the disconnected valves

Fig. 1.



Calantica (Scillelepas) dorsata, Steenstrup, sp. Danian: Faxe, Denmark. Restoration of capitulum.

c., carina; c.l., carinal latus; m.l., median latus; r., rostrum;
r.l., rostral latus; s., scutum; s.c., subcarina; t., tergum.

of the upper whorl, it was an open question whether they should or should not be referred to the group of species included under *Scillelepas*, although these valves approached more closely to the species of *Scillelepas* than to those of *Pollicipes*. Dr. K. Brünnich Nielsen's discovery, however, of a number of valves of the lower whorl of *P. dorsatus* in the Danian of Faxe, Denmark, including those here figured (Pl. VIII. figs. 16–21), enables us not only to prove that the species is a true *Scillelepas*, but also to give a restoration of the capitulum (see text-fig. 1). The capitulum is formed of a carina, paired scuta, and paired terga, with three pairs of

basal latera, a rostrum, and a subcarina. In his paper (1912) Dr. K. B. Nielsen figured only two of the basal latera (namely, a rostrum and two rostral latera), but since he still referred the species to *Pollicipes*, he did not realize the significance of these valves. All the valves of the lower whorl of *P. dorsatus* are here figured, and their structure agrees in all respects with the species of *Scillalepas*, especially *S. carinata*, Seguenza, from the Pliocene of Sicily, and the recent *S. superba*, Pilsbry. We are therefore able to prove that a true *Scillalepas* existed in the Upper Cretaceous (Danian), and the importance of this is apparent, since the remaining fossil forms are *S. paronæ*, Alessandri, from the Miocene of Italy, and *S. carinata* and *S. ornata*, Seguenza, from the Pliocene of Sicily.

Since we can prove that *P. dorsatus* belongs to *Scillalepas*, there is little doubt that *P. validus* belongs to *Scillalepas* also, although only the upper series of valves and a single rostrum of the lower whorl are known.

Phylogenetic Considerations.

In considering the phylogenetic position of the pedunculate Cirripedes *Pycnolepas*, *Zeugmatolepas*, *Calantica* (*Scillalepas* and *Titanolepas*), and the sessile Cirripede *Brachylepas*, all represented in the Cretaceous rocks, it is apparent that we are dealing with forms that have been evolved from either *Pollicipes* or a *Pollicipes*-like ancestor, and represent several lines of evolution. All these forms still retain valves of a *Pollicipes*-like character, and, since they are well differentiated in the number, relative position, and structure of the capitular valves, specialization must have begun long before the close of the Jurassic period. A point of special interest is the fact that even so early in the Cretaceous as the Cenomanian, two forms, *Zeugmatolepas* and *Titanolepas*, had independently developed in the scutum a subcentral umbo, a type of valve hitherto known only in the more specialized species of *Scalpellum*, of which the earliest species occur in the Upper Senonian. A similar development in the scutum is exhibited by the genus *Loricula*, which ranges from Turonian to the Upper Senonian.

The new genus *Pycnolepas* includes a series of species, ranging from Albian to Helvetian, in which the capitulum appears to have been formed of eight valves, and the peduncle of comparatively large plates. These capitular valves

agree with those of *Brachylepas* in number and disposition, and, except for the narrower carina and rostrum, in their structure also. The narrowness of the carina and rostrum, however, is of significance, for in this character they agree more with the pedunculate Cirripedes. *Brachylepas* is considered to be a sessile Cirripede, mainly because of the modification of the basal whorls of imbricating plates to form a shelf or platform round the base of the capitulum; and the much wider semiconical carina and rostrum allow of a closer approach of the capitulum to radial symmetry, which is in accord with this interpretation.

The great resemblance between the capitular valves of *Brachylepas* and those of the series of species included in *Pycnolepas* suggests the probability that *Brachylepas* was an offshoot from that line, which by suppression of the peduncle and modification of the lower valves of the capitulum, accompanied by widening of the carina and rostrum, had evolved into a sessile Cirripede.

It is probable that the ancestral species of *Pycnolepas* existed in the Upper Jurassic (Tithonian), for the two recently-described species, *Brachylepas* (?) *fimbriatus* and *B.* (?) *tithonicus* (1912, Geol. Mag. pp. 505-508, pl. xxiii.), each represented by a single carina from Stramberg, Moravia, agree in every way with the structure of the carina in the species of *Pycnolepas*. The relationship of those Stramberg species to *P. rigidus* and *P. fallax* was pointed out at the time, but, since the present evidence with regard to *P. rigidus* and *P. fallax* was not then known, the two Stramberg carinæ were included provisionally in *Brachylepas*, to which *P. fallax* had been referred by Dr. H. Woodward.

When we compare *Brachylepas** (text-fig. 5) and *Pycnolepas* (text-fig. 4) with the recent pedunculate Cirripede *Pollicipes mitella* (text-fig. 2), we see that *P. mitella* has precisely the same arrangement of the upper valves of the capitulum. *Brachylepas*, however, is widely differentiated structurally by the presence of several whorls of imbricating plates at the base of the capitulum, and in this character has a close outward resemblance to the recent sessile Cirripede *Catophragmus polymerus* (text-fig. 3) of the subfamily Chthamalininæ. There is fairly strong evidence, both positive and negative, to support the supposition that *Pycnolepas* has a peduncle with large plates and no lower whorl of valves,

* I have already discussed the relationship of this form with the recent Cirripedes *Catophragmus polymerus* and *Pollicipes mitella* in a former paper (see Geol. Mag. 1912, pp. 356-358).

but when we turn to *Pollicipes mitella* we see that it has a single lower whorl of valves including a subrostrum and subcarina, and with a short peduncle, which is sometimes even considerably shorter than the capitulum.

Fig. 2.

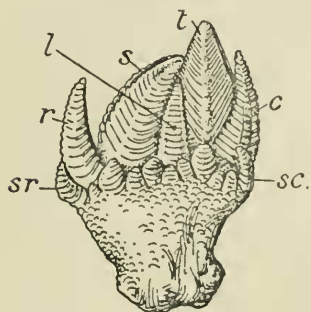


Fig. 3.

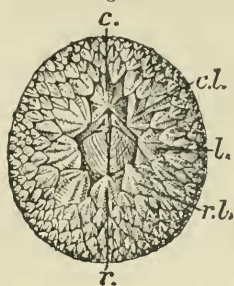


Fig. 4.

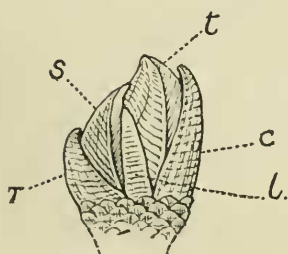


Fig. 5.

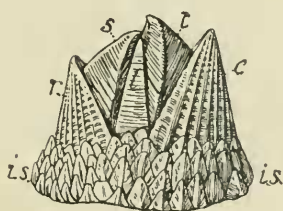


Fig. 2.—*Pollicipes mitella*, Linnæus. Living: Philippines, China, &c. (After Darwin.)

Fig. 3.—*Catophragmus polymerus*, Darwin. Living: Australian Coast. (After Darwin.)

Fig. 4.—*Pycnolepas rigidus*, J. de C. Sowerby, sp. Albian and Cenomanian, Europe. Restoration.

Fig. 5.—*Brachylepas naissantii*, Hébert, sp. Upper Senonian, Europe. Restoration.

c., carina; c.l., carinal latus; i.s., imbricating plates; l., upper latus; r., rostrum; r.l., rostral latus; s., scutum; s.c., subcarina; s.r., subrostrum; t., tergum.

The blocks for figs. 2, 3, and 5 were kindly lent by the editor of the 'Geological Magazine.'

While it may be supposed that the pedunculate *Pycnolepas* was the ancestral stock which gave rise to the sessile

Brachylepas, it is certainly interesting that *Brachylepas* should show in its structure some relationship to the sessile *Catophragmus* of the subfamily Chthamaliinæ. It is much more so when we consider that *Pollicipes mitella*, which is more closely related in the structure and disposition of the upper valves of the capitulum to *Pycnolepas* than to any other Cirripede, has also certain definite characters in common with the Chthamaliinæ. Darwin* drew attention to the fact that *P. mitella* is more nearly related to the sessile Cirripedes, especially the Chthamaliinæ, than to any others, except perhaps *Lithotrya*, and in his Monograph † states the "The Chthamaliinæ, in the structure of the mouth and cirri, and to a certain extent in that of the shell, fill up the interval between the Balaninæ and Lepadidæ; and *Catophragmus* forms in a very remarkable manner the transitional link, for it is impossible not to be struck with the resemblance of its shell with the capitulum of *Pollicipes*."

It would seem, therefore, that the relationship to the Chthamaliinæ (*Catophragmus*) of the fossils *Pycnolepas* and *Brachylepas*, and of the recent *Pollicipes mitella*, as deduced by a study of their valves, is supported by the structure of the animal's body in *P. mitella*. One might also reasonably infer that *Pollicipes mitella* is the survivor of the group of species included in *Pycnolepas*, and that it is independently tending to evolve into a sessile Cirripede through the suppression of its peduncle and a modification in the lower valves of the capitulum, just as did the early offshoot *Brachylepas*.

It is indeed probable that the sessile condition has been arrived at independently on several different lines of descent during the evolution of the Cirripedia. In a paper, now in the press, I have shown that the Verrucidæ have a phylogenetic history widely different from that of the Balanidæ (*sensu lato*), and evidence is not wanting to show that the Balanidæ also are at least diphyletic. The Chthamaliinæ have almost certainly arisen from some such form as *Brachylepas*, while it is extremely difficult, if not impossible, to derive the Balaninæ from that source or indeed from any form as yet known.

Zeugmatolepas has already been described in a former paper (Proc. Zool. Soc. London, 1913, pp. 937, 941), and it

* See Darwin, C. R., 1851, Pal. Soc. Monogr. Foss. Lepadidæ, p. 48; 1851, Ray Soc. Monogr. Cirripedia, Lepadidæ, p. 324.

† Darwin, C. R., 1854, Ray Soc. Monogr. Cirripedia, Balanidæ, p. 486.

will suffice here to say that in the number of valves of the capitulum it agrees with *Pollicipes*, but differs in the more erect and *Scalpellum*-like shape of the capitulum, in the size and position of the upper latera, and in the specialized form of the scuta, characters seen in the more specialized forms of *Scalpellum*. In fact, it is a *Pollicipes*, which, while retaining the large number of capitular valves, is developing some of the characters of a *Scalpellum*. It probably represents an early attempt at that specialization in the form and position of the upper valves which was subsequently acquired independently by the more specialized forms of *Scalpellum*.

There now remain to be considered the species grouped in the genus *Calantica*. This genus was evidently derived from a *Pollicipes*-like form, and the valves still retain their *Pollicipes*-like character, in consequence of which the fossil forms have been referred mainly to *Pollicipes*. *Calantica* differs from *Pollicipes* in the greater specialization of the capitular valves, and the capitulum is composed of only senta, terga, and a carina, with but a single basal whorl of valves, the valve which is homologous with the upper latus in other forms being still a member of the lower whorl. There are two groups of recent species, namely, an Oriental group (*Calantica*, s. str.) and a North Atlantic-Mediterranean group (*Scillelepas*). These two groups may conceivably represent two collateral stocks, but at present I am inclined to think that the species included in *Calantica*, s. str., are derived from the more primitive *Scillelepas*, mainly through the weak calcification of the basal whorl of valves. *Scillelepas* is known from the Pliocene and Miocene of Sicily and Italy respectively, and in the present paper has been shown to have existed in the Upper Senonian and Danian, but no fossil has yet been proved to belong to the more typical species of *Calantica*, s. str. The probability is that the ancestral forms of *Scillelepas* occurred in the Jurassic, but although at present there is not sufficient evidence to prove this, it is certain that some of the disconnected valves found in Jurassic rocks have much resemblance to those of *Scillelepas*. It is fairly evident that in *Scillelepas* we have a group of species intermediate between *Pollicipes* and *Scalpellum*, and therefore it is another example of the many forms that have been derived from a *Pollicipes*-like ancestor through the specialization in the number and position of the capitular valves.

The recently-described *Titanolepas**, although ranked as

* 1913, T. H. Withers, Proc. Zool. Soc. London, p. 943.

a subgenus of *Calantica*, differs in the form of the scutum from the other members of the genus. It existed in the Cretaceous (Cenomanian and Turonian), and is considered to be an early specialized form, which branched off from the main *Scillelepas* line and may eventually have given rise to the genus *Oxynaspis*.

Although we can gain some idea of the phylogenetic position of the Cirripedes discussed in this paper, even with the small number of forms and the meagre evidence at our disposal, it is obvious that a knowledge of their Jurassic ancestors would help materially. Unfortunately, the Jurassic species are known in the main only by a few disconnected valves, which give very little idea of the form of the capitulum; and until our knowledge of these forms is considerably extended, our conception of the evolution of the group, as a whole, can make little progress.

In conclusion, I wish to express my indebtedness to the following gentlemen, who have kindly helped me either by the loan or gift of specimens, or in other ways:—Prof. G. de Alessandri, Dr. F. A. Bather, Dr. H. P. Blackmore, Mr. R. M. Brydone, Dr. W. T. Calman, Mr. C. P. Chatwin, Mr. F. Leney, Dr. K. Brünnich Nielsen, Prof. C. F. Parona, Dr. J. P. J. Ravn, and Count Luigi di Rovasenda.

EXPLANATION OF THE PLATES.

PLATE VII.

Pycnolepas paronai, de Alessandri, sp.

Miocene (Helvetian): La Grangia, Colli di Torino, Italy.

Fig. 1. Rostrum.

Fig. 2. Scutum. Imperfect left valve.

Fig. 3. Tergum. With base broken off.

Fig. 4. Carina. $\times 2$ diam. Coll. R. Museo Torino. Origl. figd. G. de Alessandri, Palæontogr. Ital. 1906, vol. xii. p. 248, pl. xiii. fig. 8.

All figures, except fig. 4, nat. size.

Pycnolepas brünnichi, Withers.

Danian, Bryozoa Limestone: Faxe, Denmark.

Fig. 5. Rostrum.

Fig. 6. Scutum. Right valve, with rather narrow apico-basal ridge.

Fig. 7. Upper latus. Apex broken off.

Fig. 8. Tergum. Right valve.

Fig. 9. Carina.

All figures $\times 4$ diam.

Pycnolepas fullax, Darwin, sp.

Upper Senonian, *B. mucronata*-zone: Norwich, Norfolk (figs. 10, 11, 13, 14).

Upper Senonian, *B. mucronata*-zone (upper part): Trimmingham, Norfolk (fig. 12).

- Fig. 10. Rostrum. Norwich Castle Museum (Fitch Colln.), 2156 c.
 Fig. 11. Scutum. Brit. Mus. (Nat. Hist.), I. 14466.
 Fig. 12. Upper latus. R. M. Brydone Colln. Figd. II. Woodward, Geol. Mag. 1906, p. 344, fig. 21.
 Fig. 13. Tergum. Norwich Castle Museum (Fitch Colln.), 2153 c. The original tergum (paratype) of Darwin, 1851, Pal. Soc. Monogr. Foss. Lepadidæ, p. 76, pl. iv. fig. 8 b.
 Fig. 14. Carina. Brit. Mus. (Nat. Hist.), I. 14467.

All figures $\times 2$ diam.

Pycnolepas rigidus, J. de C. Sowerby, sp.

Albian, Gault: Folkestone, Kent.

- Fig. 15. Rostrum. }
 Fig. 16. Scutum. }
 Fig. 17. Upper latus. } a, outer view; b, inner view.
 Fig. 18. Tergum. }
 Fig. 19. Carina. }

Figs. 15, 16, 18, 19, $\times 2$ diam.; fig. 17, $\times 4$ diam.

PLATE VIII.

Pycnolepas rigidus, J. de C. Sowerby, sp.

Albian, Gault: Folkestone, Kent.

- Fig. 1. Peduncular plate. Outer view.
 Fig. 2. " " Inner view of an incomplete example, showing the median basal socket.
 Fig. 3. " " Inner basal view of another example.

All figures $\times 8$ diam.

Cenomanian, Chalk Marl: near Cambridge.

- Fig. 4. Scutum. Left valve showing very prominent apico-basal ridge, which projects beyond the basi-lateral angle. $\times 4$ diam.

Pycnolepas fullax, Darwin, sp.

Upper Senonian, *M. cor-anguinum*-zone: Quidhampton, nr. Salisbury, Wilts.

- Fig. 5. ? Rostrum. a, side view; b, outer view. $\times 2$ diam. Dr. H. P. Blackmore's Colln.

Pycnolepas brünnichi, Withers.

Danian, Bryozoa Limestone: Faxe, Denmark.

- Fig. 6. Scutum. Left valve, with very broad apico-basal ridge. $\times 4$ diam.

Pyenolepas scalaris, Withers.

Cenomanian, Chalk Marl: near Cambridge.

Fig. 7. Rostrum. *a*, outer view; *b*, inner view.

Fig. 8. Rostrum. A smaller example in which the longitudinal ridges are not so pronounced.

Fig. 9. Upper latus. *a*, outer view; *b*, inner view.Fig. 10. Scutum. *a*, outer view; *b*, inner view.Figures $\times 8$ diam.*Calantica (Scillelepas) valida*, Steenstrup, sp.

Upper Senonian: Ciply, Belgium.

Fig. 11. Rostrum. Outer view. $\times 2$ diam. Brit. Mus. (Nat. Hist.), 38460.*Calantica (Scillelepas) dorsata*, Steenstrup, sp.

Danian, Bryozoa Limestone: Faxø, Denmark.

Fig. 12. Carina. (With apex broken.)

Fig. 13. Tergum. Right valve.

Fig. 14. Scutum. Large right valve.

Fig. 15. Scutum. Young left valve.

Fig. 16. Carinal latus.

Fig. 17. Rostral latus. Left valve.

Fig. 18. Rostrum.

Fig. 19. Rostral latus. Right valve.

Fig. 20. Median latus.

Fig. 21. Subcarina.

Figs. 22, 23. Peduncular plates. *a*, outer view; *b*, inner view. $\times 8$ diam.} Outer views. $\times 1\frac{1}{2}$ diam.} *a*, outer view; *b*, inner view.
 $\times 4$ diam.

XXVI.—*Description of a new Species of Terrestrial Isopoda from India.* By WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.

[Plate IX.]

I AM indebted to the kindness of Dr. A. D. Imms, of the University of Manchester, for a tube of terrestrial Isopoda containing three specimens, two adult and one young, referable to the genus *Porcellio*, Latreille, collected by him at Allahabad.

During the past few years I have examined a considerable number of terrestrial Isopoda from this region, including many species of *Porcellio*; I cannot, however, find that the present species agrees with any of these or with any that have been previously described.